CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

- The precipitation of asphaltenes depend both on time and precipitant concentration.

- The correlation between onset times and $(\delta_{asph} - \delta_{solution})^2/\mu_{solution}$ has same slope and trend in every crude oils. Therefore, the aggregation rates of asphaltenes are controlled by the interaction forces between asphaltenes and solution and their diffusion rates in the mixture.

- The fraction that precipitated earliest in the characterization experiments (*Cut 1*) has the least solubility in toluene, chloroform, methylene chloride and tetrahydrofuran. For high temperatures experiment, the insoluble particles are soluble in toluene and some of insoluble particles are soluble in heptanes. Solubility of insoluble particles in toluene increases by adding soluble asphaltenes. Therefore, *cut 1* contains waxes and asphaltenes. *Cut 1* had the highest H/C ratio and number of carbon per alkyl side chain but it had the lowest aromaticity. These results are affected of waxes in *cut 1*.

- Asphaltenes that precipitated earlier except *cut 1* have higher heteroatoms, metal contents but less number of carbon per alkyl side chain. The particle size of nanoaggregates and aromaticity are similar. It demonstrates that asphaltenes that precipitated earlier are more unstable. However, the difference in properties of asphaltenes that precipitated for different cuts is not significant different.

5.2 Recommendation

- To get better understanding about asphaltene precipitation, the chemical compositions such as saturates, aromatics, resins, and asphaltenes should be used to correlate with aggregation rates.

- To get better understanding in the properties of asphaltenes that precipitated at different times and precipitant concentrations, the properties of asphaltenes that precipitated earliest (*Cut 1*) should be analyzed. The centrifugation with elevated temperature will be performed to separate asphaltenes from waxes in *cut 1*. Asphaltenes that are separated using this procedure should be analyzed using characterization techniques such as SAXS and NMR.